# Guidelines for Assessing and Managing Asthma Risk at Work, School, and Recreation

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## PURPOSE AND GOALS

Health care providers frequently are asked to advise patients with asthma about the circumstances in which they can work or pursue high-risk activities. Several national organizations have developed guidelines to aid the practitioner in addressing this task. The most widely disseminated policy statement, the *Guidelines for the Diagnosis and Management of Asthma* developed by the National Asthma Education and Prevention Program (NAEPP) (1, 2), focuses mainly on nonoccupational risk factors. Although a special section gives additional brief guidance on the management of occupational asthma, issues concerning what activities patients with asthma should avoid or undertake with extreme caution are not addressed.

In addition to the NAEPP guidelines, there are several other consensus or policy statements on the management of asthma in various settings (3–6). Most of these focus on the pharmacologic management of asthma, either in preventing exacerbation or in rescue management. The American College of Chest Physicians (3) consensus statement takes the most comprehensive approach to workplace asthma, focusing on diagnosis and management of the sick worker, rather than preventing exacerbations in someone with preexisting asthma. Health providers need more detailed guidelines to counsel and advise individuals with asthma on how to live their lives fully, while minimizing their risk for significant illness.

The specific goals of this statement are to review public health, ethical, legal, policy, and behavioral issues that impact on asthma management; develop a consensus approach to evaluating a patient with asthma considering employment in a specific workplace; outline the medical, behavioral, workplace, and management issues that should be considered in assessing an individual's fitness for work, school, or recreation; create a basis for school and parent groups to be advocates for environmental health; provide guidelines for recommending accommodations in the workplace that incorporate the provisions of the Americans with Disabilities Act (7); and establish guidelines for special activities that may impact adversely on patients with asthma.

The target audience for these guidelines includes all health care practitioners, workplace managers, school administrators, and the general public.

## KEY CONSIDERATIONS

### Prevention Factors

Prevention focuses on modification of environmental and behavioral factors. Preventive pharmacotherapy and reduction/elimination of asthma triggers are the most effective approaches to minimizing the health risks of asthma (1). Preventive efforts are categorized as primary, secondary, and tertiary. In most instances the earlier the phase of prevention, the more effective it is in reducing illness and the financial impact of asthma.

Primary prevention refers to the reduction or elimination of risk factors that cause disease *de novo*. Examples of primary prevention include reduction of house dust mite antigen levels in the homes of high-risk young children and the use of powder-free and low-latex protein gloves in health care facilities.

Secondary prevention is the detection and subsequent management of previously undiagnosed patients through the use of tests that are both sensitive and specific. Questionnaires, skin tests, and pulmonary function or bronchoprovocation tests to detect hyperresponsiveness or sensitization are examples of screening for asthma.

Tertiary prevention reduces disease morbidity in individuals with existing disease. Preventing asthma exacerbations through regular use of antiinflammatory medication or removal of sources of antigen is an instance of tertiary prevention. Examples include the removal of sources of antigen (such as a cat) from the home of a child with asthma and cat sensitivity, and the substitution of non-isocyanate-containing spray paints in the workplace of an adult with isocyanate-induced asthma.

Although effective primary preventive measures are most appropriate for reducing overall morbidity and mortality from asthma, this American Thoracic Society statement focuses on reducing asthma symptoms and exacerbations among those with preexisting asthma.

### Environmental Factors

Asthma results from a complex interaction between the individual and his or her environment. Noninfectious agents involved in the development or exacerbation of asthma are generally encountered as an aerosol (e.g., dusts, mists, and fumes) or as a gas (including vapors). Exercise or exposure to cold air may also trigger exacerbations, particularly when ambient ozone levels are elevated (8). Exposures in the home, recreation, and working environments

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are now recognized to be critically important in the initial onset of asthma and the triggering of attacks (1, 4, 9, 10).

In many patients, environmental modifications can improve asthma control while reducing medication requirements. Thus, careful attention to environmental factors affecting asthma is recognized as an essential component of asthma management (1, 11).

### Behavioral Factors

The implementation of environmental controls to reduce exposure to asthma triggers requires a behavioral change for the patient with asthma and others, such as an employer, school principal, or governmental agency. For example, modification of the home environment, including changing home furnishings, prohibiting smoking, and eliminating pets, necessitates cooperation and compromise among all family members. Successful environmental control should be accompanied by appropriate education to inform all household members about the rationale and benefits of environmental controls (1).

Asthma education is a necessary prerequisite to each patient's awareness of the importance of environmental control, self-monitoring, and pharmacologic therapy. Individualized and group asthma self-management programs can be useful in reinforcing preventive management, debunking myths, and encouraging regular asthma health care (12, 13). Courses that provide specific knowledge and skills in asthma education are available for health care personnel, such as work site or school nurses (*see* http://www.lungusa.org/asthma/asthma_cert.html, http://www.cnac.net/english/certification.html). Although asthma education has generally been considered to be patient focused, extending asthma education to include the general public can facilitate adherence with broad environmental control interventions, such as smoking bans or restrictions on exposure to irritants, such as perfumes. Education of workers (both with and without asthma) and employers about asthma risks in specific settings can facilitate early recognition of illness and encourage environmental control (9, 14).

## SETTINGS

Guidelines to aid clinicians in advising patients with asthma on activities in various settings must account for preventive, environmental, and behavioral factors that minimize risk and maximize function. The following sections on work, school, and special situations and recreation incorporate each of the factors.

### Work

***Definition.*** Several definitions have been proposed for occupational asthma (OA) and work-related asthma (4, 14, 15). In this statement, OA is defined as asthma caused by work exposure, and work-related asthma encompasses both OA and asthma aggravated by work or the work environment.

***Impact.*** In developed countries, asthma is now the most common occupational lung disorder. Among adults with asthma, the proportion experiencing onset or worsening of symptoms due to work varies by region. Population-based studies have estimated that the proportion of adult onset asthma due to occupational exposures ranges from 5–10% (Europe), 10–23% (United States), to 17–29% (Finland) (16–18). The differences among studies in the observed disease burden likely depend on the specific substances used by industries in the countries, the number of workers employed and at risk, the effectiveness of regulatory or voluntary exposure controls, and the specific research design of the studies. In some countries, ongoing surveillance has documented a steady rise in the number of new OA cases. The proportion of persons with asthma who experience worsening symptoms due to work activities or environments has not been as well studied. As the rates of OA have increased, evidence also indicates that the socioeconomic impacts are greater than was previously recognized. Unemployment or sharp reductions in income are frequent outcomes among persons who have been diagnosed with OA (19).

***Workplace factors that adversely impact asthma.*** Similar agents and physical factors that cause or exacerbate asthma in the home or school environment may also do so in the work environment. However, intensities and frequencies of exposures may be much greater in certain workplaces.

There are several mechanisms recognized in the development of work-related asthma symptoms:

1. Sensitization: Occupational exposure to high molecular weight allergenic compounds, generally plant, animal, or microbial proteins, can result in immunologic sensitization. Sensitization and development of asthma can also be initiated by occupational exposures to a number of low molecular weight chemical substances that are less often encountered outside of the workplace (e.g., diisocyanates, plicatic acid in red cedar, platinum salts). Subsequent workplace exposures to the initiating agent may trigger bronchospasm, perpetuate airway inflammation, and progressively increase the degree of nonallergic airway responsiveness. The increased nonallergic hyperresponsiveness results in asthma symptoms that are triggered by a variety of exposures, both in and out of the workplace. With continued exposures, asthma symptoms and nonallergic hyperresponsiveness persist in a majority of person with OA, even if they have completely terminated all exposures to the initiating substance (20).
2. Reactive airways dysfunction syndrome: In previously healthy individuals, a single high-level exposure to an inhaled respiratory tract irritant may result in persistent asthma-like symptoms (reactive airways dysfunction syndrome), which develop within hours of the exposure. There are reports suggesting that repeated lower level exposures to irritants at work may also result in airway hyperresponsiveness (21, 22).
3. Nonimmunologic airway irritation in preexisting asthma (irritant-induced asthma): Work-related asthma symptoms can result from inhalation of a variety of irritating aerosols, dusts, gases, and fumes (e.g., cleaning materials, chlorine, sulfur dioxide). Symptoms may also be triggered by the disparity between the ventilatory requirements of vigorous work and the asthma patient's ventilatory capacity (which may be reduced by exercise-induced bronchospasm, especially in cold, dry air) (4).
4. Poor indoor environments with biologic contaminants: Certain home, school, and office environments have also been recognized to trigger asthma symptoms, although the mechanisms are not well understood. Bacteria, fungi, and other contaminants in furnishings and ventilation systems have been implicated (23, 24).

***Assessment.*** Work may have positive and/or negative consequences for individual patients with asthma, depending on the specific job. Physicians may be asked to assist in evaluating the likelihood that accepting employment in a specific job will affect asthma control, as well as potential consequences of asthma symptoms during work. Recommendations must be individualized, taking into account the factors listed in Table 1. A trial at work, with close medical management and monitoring, may be appropriate. In general, employment should not be recommended if the patient has demonstrated specific sensitization to a potential workplace agent (e.g., bakery uses amylase, patient with specific IgE to amylase).

For patients with asthma who are currently employed, the clinician must work jointly with the patient to determine whether

**TABLE 1. ABCs FOR ASSESSING A PATIENT WITH ASTHMA CONSIDERING SPECIFIC EMPLOYMENT**

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| Adverse job factors |
| Exposure to specific sensitizers |
| Exposure to nonspecific irritants, extremes of temperature/humidity |
| Altitude/atmospheric pressure |
| High job energy and ventilatory requirements |
| Inability to access medications (e.g., underwater diving) |
| Beneficial job factors |
| Improved environment during work (e.g., better conditioned air versus home) |
| Access to appropriate health care (e.g., health insurance coverage) |
| Better access to medications |
| Improved socioeconomic status (e.g., ability to control stress, improve housing) |
| Consequences of asthma at work |
| Job safety or health risks (e.g., confined space) |
| Use of respiratory protection in hazardous environments |
| Prior asthma severity and control |

work activities or exposures are affecting the patient's clinical status. The structured approach described below increases the likelihood of a beneficial outcome (16). Certain steps are generally necessary: (*1*) identification of relevant potential job exposures, (2) obtaining available information concerning effects of the exposures, and (*3*) acquiring clinical data to assess the impact of the exposures. The following sections deal with optimizing these steps.

1. Identifying exposures: The clinician should inquire about any potential asthma-triggering or -inducing exposures in the workplace even if the patient's symptoms do not prompt questions about potential exposures at work (4). The initial occupational history should focus on the patient's current job activities, and other nearby processes that may result in exposures. It is helpful to roughly quantify the intensity of airborne exposures by asking about visible dust, odors, and mucous membrane irritation, although low exposures can trigger symptoms in sensitized persons. Past employment and exposures should be identified. Reviewing a list of potential sensitizers may assist the patient in identifying problem exposures (Table 2). Additional inquiries can be based on knowledge of the specific job and prior experience. Specific questions should also cover work exposures to common asthma triggers, including exertion (especially in cold weather), plant pollens, animal dander, dust mites, insects, molds, and irritants (perfumes, paint, cleaning solutions, chemicals, tobacco smoke, etc.).

   There are certain work exposures, processes, industries, and occupations that have been associated with the onset or worsening of asthma, and should raise the index of suspicion. Low molecular weight asthma inducers are generally highly reactive chemically, and are often used in paints, coatings, foams, plastics, and similar products. A patient's report of such products in the workplace should trigger a careful inquiry for potential sensitizers and irritants that may have caused or worsened asthma. Work that generates dust, such as the use of abrasive materials or devices, work locations in which there are strong odors, or where combustion or chemical reactions are taking place, are often problematic. However, allergic respiratory diseases have been reported in a variety of work settings, including agricultural, biotechnology, industrial, retail, office, and home environments (25).

   In the United States, work exposure information is generally available to the patient under the Federal Hazard Communication regulations (26) or through specific state laws. These require that Material Safety Data Sheets (MSDSs) or their equivalents be provided for all chemicals used in the workplace. The MSDSs are required to state the components of the materials, their physical and chemical properties, and recognized health concerns, and thus can be quite helpful in identifying respiratory tract irritants or sensitizers. Unfortunately, MSDSs are not always consistent in their format and content, and may not identify sensitizing substances as such. Some relevant exposures may not be listed on MSDSs if they result from reaction products or microbial contamination (e.g., in metal working fluids), or are in low concentrations (less than 1%).

   In some situations, an additional source of exposure information may be available if workplace management has consulted industrial hygiene specialists to perform environmental measurements. Unfortunately, for many asthma-causing or -triggering substances, neither industrial hygiene-monitoring methods nor criteria for assessing risk are sufficiently well developed to be useful in individual patient management. Obtaining information about a specific job, or workplace industrial hygiene results, may require direct communication between the health care provider, the patient or his/her representative, and workplace safety personnel or management. These discussions should be initiated with care and always with the patient's concurrence, because at times conflict, and possible retaliatory actions, can result.
2. Available information: Information should be sought that describes any recognized association between specific workplace exposures and asthma. This information may be accessed through a variety of sources (Table 3), including published materials, electronic data sources, trade organizations, unions, consultations with occupational medical specialists, academic centers, and government agencies, such as the National Institute for Occupational Safety and Health (NIOSH). Unfortunately, only a limited number of dusts, chemicals, or other respiratory irritants have been systematically evaluated for effects on workers with asthma.
3. Clinical evidence: Additional clinical data are important in defining relationships between the suspect exposures and the patient's symptoms (3, 27). Clinicians should be aware of various patterns of asthma symptoms associated with occupational exposure, including the onset of symptoms shortly after starting a work shift or after leaving work at the end of a shift, or resolution on days off or vacations. Upper airway symptoms and ocular symptoms often precede lower airway symptom and should be considered a potential harbinger of asthma. When asthma is actually *initiated* by a sensitizer at work, the likelihood of recovery is greatest with early recognition and prompt control of exposure. Time expended clarifying the findings early in the course is more likely to result in improved patient health over the long term.

**TABLE 2. EXAMPLES OF POTENTIAL AGENTS CAUSING ASTHMA OR ASTHMA-LIKE SYNDROMES***

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| 1. Animal and birds (including their parts, bedding, and waste) |
| 2. Seafood (e.g., crab, shrimp) and fish |
| 3. Insects (e.g., cockroaches) and insect parts |
| 4. Plant parts, including wood and grain dusts, vegetable gums, and baking flour |
| 5. Pharmaceuticals and enzyme powders (e.g., detergents and dough additives) |
| 6. Diisocyanates (e.g., in glues, coatings, paints) |
| 7. Anhydrides (in epoxy, resins, plastics) |
| 8. Amines (in shellac, lacquer, hairdressing, paint, plastics, resins) |
| 9. Solder fluxes, colophony |
| 10. Metal dusts and salts (e.g., platinum, nickel, cobalt, chromium) |

* This is an abbreviated list of agents. More comprehensive lists of agents can be found in References 9 and 14.

**TABLE 3. SOURCES OF EXPOSURE-RELATED INFORMATION**

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| Workplace safety and health personnel |
| Occupational medicine specialists |
| Allergy and pulmonary medicine specialists |
| Academic occupational clinics |
| NIOSH Education and Research Centers |
| Private environmental consulting firms |
| Textbooks of occupational respiratory medicine |
| Material Safety Data Sheets (MSDSs) from product manufacturers |
| National Library of Medicine (http://www.nlm.nih.gov/) |
| Federal agency publications (NIOSH, NHLBI, EPA, NIEHS, NCEH) |
| Professional organization publications (ALA/ATS, AAAAI, ACAAI, ACCP) |
| Electronic databases and Web sites |
| National Institute for Occupational Safety and Health (NIOSH) http://www.cdc.gov/niosh/homepage.html * |
| National Heart, Lung, and Blood Institute (NHLBI) http://www.nhlbi.nih.gov/nhlbi |
| National Institute of Environmental Health Sciences (NIEHS) http://www.niehs.nih.gov * |
| U.S. Environmental Protection Agency (USEPA) http://www.epa.gov |
| University of Edinburgh Occupational Asthma http://www.med.ed.ac.uk/hew/work/ocasthma.html |
| Association of Occupational & Environmental Clinics (AOEC) http://www.aoec.org |
| UK Health and Safety Executive http://www.open.gov.uk/hse/hsehome.htm |
| Asmanet http://www.recomp.fr/asmanet |
| Database of Hazardous Chemicals and Occupational Diseases http://www.haz-map.com/oa.htm |
| American Thoracic Society (ATS) http://www.thoracic.org |
| American Academy of Allergy, Asthma, and Immunology (AAAAI) http://www.aaaai.org |
| American Lung Association http://www.lungusa.org |
| American College of Chest Physicians (ACCP) http://www.chestnet.org |
| American College of Occupational and Environmental Medicine http://www.acoem.org |

* Searchable for references.

Additional clinical information should include determining the pattern of symptoms, specific immunologic responses (e.g., skin tests, RAST, or ELISA immunoassays), and airway physiology (peak flow diaries, serial spirometry, and specific or nonspecific inhalation challenges) (16). Serial measures of peak expiratory flow or $FEV_1$ have been widely utilized (28). Symptom diaries with spirometry at least four times a day, using a lightweight inexpensive device, can be effective for evaluating asthma at work. Formal technician-coached spirometry, performed before and after the work shift, may be helpful when exposures are to suspected pharmacologic bronchoconstrictors such as dusts from cotton, flax, and hemp. Spirometry may be less useful for sensitizer-induced asthma due to delayed and sometimes prolonged bronchoconstrictive responses that extend into the next work shift (3, 16, 29, 30). Formal monitoring also may help assess lung function when there is a question of the reliability of effort or self-reporting by the patient. Documenting job-related increases in nonspecific airway responsiveness (e.g., to methacholine) has been used in evaluating the relationship between job exposures and asthma severity. Airway responsiveness is tested after a period of at least 2 weeks away from the suspect job environment, and compared with results after several weeks of exposure on the job.

For each of these tests, clear clinical responses to exposures may be present early in the course of sensitizer-induced OA and, if detected, can be useful in implicating specific environments or activities. However, if work exposures continue, the patient's level of nonspecific airway responsiveness may increase and remain elevated. At this point, many substances both in and out of the workplace can trigger bronchospasm, and the relationship between the work exposures and symptoms or airflow limitation becomes less clear. Responses from exposures to faulty air-handling systems or contaminated furnishings in schools or office buildings may also be difficult to recognize clinically.

When a pattern of symptoms or airflow limitation in relation to work is not clearly identified, consultation with an experienced occupational and environmental medicine specialist can be particularly helpful in determining the contribution of work exposures to asthma symptoms. Many academic centers, including NIOSH-funded Education and Research Centers, have occupational and environmental clinics that can offer comprehensive support in evaluating work-related illness. Specialized immunologic and pulmonary function test results, including challenge studies, may at times be essential in assessing the role of the work environment in an individual patient. Consultation with allergy, occupational, and environmental medicine or pulmonary specialists may also be valuable in relation to obtaining and interpreting these findings.

***Interventions.*** If adverse effects from work are suspected, the next steps are to assess potential remedial and preventive interventions, recommend those deemed feasible, and monitor their effectiveness. The physician may be asked to provide guidelines to assist the patient in controlling symptoms while maintaining productive employment. The clinician may recommend accommodations, including exposure control, personal protective devices, and monitoring of employee health (*see below*). When communicating with the employer, the clinician should address three areas: (*1*) work ability ("what the patient can do"); (*2*) work disability ("what the patient cannot do"); and (*3*) accommodation: worksite changes that may improve the ability of the patient to work. The degree to which an asthma attack would represent a serious health or safety risk ("criticality") must be addressed as well. Appropriate protection of the confidentiality of medical data is also required in communication with employers. Supervisors and other nonmedical personnel should be given only a specific diagnosis or health information directly relevant to the job. The goal of all clinician–management communications is to optimize the patient's status as a productive and functional individual, while minimizing impacts on the patient's health and economic well-being.

1. Accommodation: Accommodation is the modification of work to allow an individual to continue working. Responsibility for "reasonable accommodation" rests with the employer, but depends on good communication from clinicians. The Equal Employment Opportunity Commission, which enforces the Americans with Disabilities Act (7), defines "reasonable accommodation."

   The degree of control needed varies among different patients with work-related asthma, and it is therefore essential to determine whether asthma was initiated by allergic sensitization to a workplace agent or is only a nonspecific or irritant effect of the work exposure(s). When asthma is induced by a workplace sensitizer, prompt and strict exposure control should be recommended, not only to control current symptoms, but also to reduce the likelihood of permanent airway hyperresponsiveness. For workers with sensitization to low molecular weight sensitizing agents (e.g., diisocyanates), complete cessation of exposure is considered the best approach. In contrast, symptoms due to irritant exposures are more dose

dependent, and a reduction in exposures generally results in a commensurate improvement in symptoms. In patients with preexisting asthma that is worsened at work, if irritant exposures are reduced sufficiently to control symptoms, an adverse long-term effect of continuing low-level irritant exposures has not been documented, although more study is needed.

In practice, many persons with asthma function well in their chosen workplaces by careful avoidance of certain situations, pacing of work, and judicious use of appropriate medications (31). When patients come to medical attention for work-related asthma, it is usually because further assistance from the physician is needed. Physician recommendations for exposure reduction and control are an essential component of asthma management (tertiary prevention). Such recommendations should be specific to the workplace factor(s) that are implicated in the patient's reduced functional status. Moreover, the recognition of a patient with OA is considered a sentinel event, and should motivate consideration of health screening of all exposed employees, to determine whether other cases are occurring (secondary prevention). In addition, appropriate control measures should be instituted for every worker in the job.

A hierarchy of exposure controls is available to assist the clinician and employer in the control of asthma initiated or exacerbated in the workplace. Generally, those that do not require active participation of the employee with asthma are more reliable. Removal of the offending material and substitution of a nontoxic alternative are the most desirable interventions, because they eliminate the asthma hazard without requiring ongoing maintenance of engineering controls or intensive monitoring of health and exposures. For example, in latex-induced asthma, substitution of nonlatex gloves for the affected worker and the utilization of powder-free and low-protein gloves by coworkers can control symptoms in the affected worker, but also help to prevent ongoing exposures that can initiate asthma (32). If substitution is not possible, engineering controls, such as enclosure of the process and/or establishment of effective local ventilation, which exhausts the agent from the worker's breathing zone, are often useful. These controls are particularly feasible when the employee works at a constant location and regularly does the same tasks.

Once exposures are controlled, changes in work practices or job organization may also be helpful. For example, if a worker with asthma does not tolerate one job task, this aspect may be reassigned to other workers (e.g., if peak exertion is a limiting factor, it is often possible to provide assistance by another worker). Typically, the Americans with Disabilities Act (7) has been interpreted by the Equal Employment Opportunity Commission to require that large employers with extensive resources be expected to make sizable investments (e.g., extensive ventilation systems) to accommodate a single worker, whereas a small company operation would not be so expected. The physician is not in a position to determine whether a recommended accommodation is "reasonable" or feasible. However, clear and specific recommendations from the clinician, based on his or her expert assessment of the likely influence of the work environment on the course and prognosis, are helpful, and carry considerable weight. Broad statements such as "no exposures to gases, mists, dusts, and fumes" must be eschewed.

In some circumstances, particularly when a worker has sensitizer-induced asthma such as that due to diisocyanates, the only feasible way of reducing exposures and controlling symptoms is to exclude the affected individual from the workplace. Even then, without appropriate exposure reduction, other workers may be at risk for developing asthma.

2. Respiratory protection: Use of respirators can also reduce exposures, although prolonged or regular use should not be requested. If the exposure is infrequent and brief, the use of a respiratory protective device may allow some patients to continue usual duties uninterrupted by symptoms. Effective use of respirators requires worker adherence to a comprehensive and professionally guided program to assure correct device selection, fit testing, maintenance, and user training (33). Use of respirators may be less consistent among persons with asthma symptoms (29). Physicians should not recommend specific types of respirators unless they have formal training in occupational medicine and an adequate understanding of respiratory protection and industrial hygiene. Patients with asthma should also be discouraged from independently purchasing dust masks or other respirators without professional guidance. Although respirators may in some circumstances be adequate for control of irritant-triggered asthma symptoms, they have not generally been considered safe for sensitizer-induced asthma. However, several studies have suggested that interventions, which include respirators and other environmental controls to lower exposures, may be useful even in sensitizer-induced OA (34, 35).

   Respirator use may be required on a routine basis for workers in certain jobs. In such situations, comprehensive programs to assure respirator effectiveness are generally required by health and safety regulations. In these workplaces, a preplacement medical fitness evaluation of respirator users often is limited to a questionnaire. However, for persons with asthma, referral for a more detailed pulmonary assessment is often necessary. A decision about placement of an employee with respirator use is ultimately the responsibility of the employer rather than the physician, but the opinions of the treating and consulting physicians are quite important. The American Thoracic Society guidelines on respiratory protection (33) and OSHA regulations (36) should be consulted.
3. Periodic monitoring: Periodic assessments of symptoms and objective criteria of lung function can help the clinician assess exposure control efforts, and identify specific activities or exposures that affect work ability and asthma risk (37). Demonstration of consistent drops in airflow after certain tasks or exposures strongly suggests inadequate protection of the individual patient. Conversely, repetitive demonstration that a task or exposure is not associated with a drop in airflow can reassure the worker, physician, and management that adequate control is in place. Patients with sensitizer-induced asthma who remain potentially exposed must be carefully monitored, because fatalities have been reported (20).

### Schools

Asthma affects 7–10% of children and in any given classroom there will usually be at least one student with asthma (10, 38). Asthma is a major cause of school absences, which can adversely affect school performance and also result in lost workdays for parents (39). In one study of low-income families, children with asthma had twice the odds of grade failure compared with children without asthma (40). On school days, children spend approximately one-third of their time in school, and when after-school activities are included, this can account for a total of 35–50 hours/week on school property (11). The importance of environmental controls in the school cannot be overestimated (1).

Goals for students with asthma should include minimizing morbidity and absenteeism, avoiding stigma, and allowing full participation in all school activities (1, 38, 41). However, students with asthma face a variety of barriers to achieving these goals

(13). Childhood asthma tends to be underrecognized and undertreated, leading to excess morbidity. School personnel should be encouraged to understand asthma, and policies should be instituted to ensure ready access to medications and appropriate responses to asthma exacerbations (42).

Environmental control in schools has been difficult to achieve. More than half of schools report at least one environmental problem that affects indoor air quality (11, 12), but many school districts have limited financial resources for environmental assessment and correction of identified problems. Exposures to potential triggers affect not only students, but also school staff with asthma (24). Environmental controls, careful housekeeping and maintenance, and targeted policies are the most appropriate measures to reduce the triggering of asthma symptoms in the school setting (43, 44).

Previous studies have linked elevated ambient ozone levels and other air pollutants with exacerbations of asthma. The American Academy of Pediatrics Committee on Environmental Health has issued guidelines on ambient air pollution and respiratory hazards to children. Practitioners "…can make parents aware of the predictable daily variation in ozone, especially the tendency to peak in the afternoon. This awareness is essential in areas with recognized high ozone levels. When ozone levels are elevated, it may be possible to decrease children's exposure by scheduling outdoor sports earlier in the day" (45).

The NAEPP guidelines (1, 2), the Environmental Protection Agency's Indoor Air Quality Tools for Schools Program (12), and the Individuals with Disabilities Education Act (46) form the basis for recommendations on establishing a safe school environment for patients with asthma, children and adults alike. Table 4 summarizes the elements of the Tools for Schools Program. To reduce asthma risks, schools should adopt appropriate policies, promptly correct environmental problems, and consider asthma impacts during new construction and renovations. Finally, parents of children with asthma need to be alerted to symptoms occurring at school, since it is ultimately their responsibility to ensure that their child's asthma is under good control. Environmental triggers in the home should also be eliminated wherever possible.

**TABLE 4. CONTROLLING SCHOOL-RELATED ASTHMA***

Eliminate environmental triggers
- Maintain HVAC system to ensure low levels of indoor humidity (including when schools are closed)
- Prevent and promptly correct water damage and mold growth
- Maintain a clean and pest-free environment
- Prohibit warm-blooded animals in classroom
- Eliminate reservoirs of dust mite and cat antigen, such as carpeting
- Engage industrial hygiene consultation when asthma triggered in school

Adopt preventive policies
- Establish a parent–employee–administration health and safety committee
- Enforce written health and safety policies and plans
- Limit outdoor activities on days with high ozone levels or other air pollutants
- Notify parents and employees of potential asthma triggering activities (e.g., pesticide application, painting, renovations)
- Schedule potential asthma-triggering activities on weekends or holidays

Raise asthma awareness among school personnel
- Educate appropriate staff about preventing, recognizing, and responding to asthma symptoms
- Ensure coaches, physical education teachers, and school nurses are aware of students with asthma
- Encourage school personnel to alert parents to symptoms observed in school
- Work toward elimination of any stigma associated with asthma

Facilitate appropriate access to asthma medications
- Encourage local policies and state regulations that permit students of adequate maturity to carry and use inhalers
- Ensure presence of a responsible adult to treat students who cannot self-administer
- Maintain up-to-date written asthma action plans on file for students with asthma
- Encourage appropriate warm-up and medications before exertion, when necessary
- Consider access to asthma medications when planning field trips

* Adapted from the U.S. EPA: Indoor Air Quality Tools for Schools, 1995.

### Special Situations and Recreation

Patients with asthma may have concerns about engaging in high-risk recreational activities in which the danger of the activity is compounded by the potential for an asthma exacerbation. As a result, individuals may limit their activities for fear of exacerbating their asthma or because of concern that they may endanger others in high-risk environments, such as self-contained underwater breathing apparatus (SCUBA) diving, subsurface exploration, mountain climbing, and other situations. However, there are minimal data showing that high-risk recreational activities significantly increase the frequency of exacerbations in appropriately treated patients with asthma (47). Overall, there is little available research to support restrictions for most of these activities, beyond ensuring that patients with asthma optimize their therapy before and during these activities. Patients with normal airway function and minimal airway reactivity may have no greater or only minimally greater risk for exacerbations than otherwise healthy individuals.

Potential concerns during scuba diving, for example, include inhalation of cold dry air, hyperventilation, extreme exertion, barotrauma to the upper and lower airway, pulmonary edema, and omission of medication doses. Individuals with asthma who have a history of few or no symptoms can still have pulmonary function findings of airflow limitation and gas trapping, which could place them at risk when scuba diving. Patients with well-controlled, stable asthma with normal spirometry, and who understand the risks of scuba diving and take proper precautions, seem to have only a slightly increased risk over the general population (47–49).

Patients considering activities in these special situations should have their asthma severity and control reviewed, undergo spirometry, and have an action plan in place with access to emergency rescue medication. With these precautions, asymptomatic patients with asthma with normal pulmonary function and minimal medication needs may participate in high-risk activities or special environmental situations. These recommendations are based on consensus and provide guidelines to clinicians and patients considering any of these activities.

## IMPAIRMENT AND DISABILITY

Despite optimal therapy for asthma and the institution of appropriate workplace accommodations to reduce the effects of irritants or sensitizers on airway mechanics, certain individuals remain unable to work. In some instances, they may be disabled for all work, whereas in others, they may have disability only for specific jobs or tasks. The 1993 American Thoracic Society statement on impairment and disability (50) delineated guidelines for the evaluation of asthma, including occupationally related airway disease. These guidelines, however, remain underutilized because of the lack of uniformity of criteria among the different disability programs administering the policies. The most recent edition of the American Medical Association guidelines on evaluating impairment and standardization of disability criteria (51), particularly in the asthmatic population, is extremely helpful in guiding workers through the legalistic maze. The 1993 American Thoracic Society statement guidelines form the basis of these new American Medical Association guidelines.

For example, the use of inhaled steroids or short-course prednisone therapy for asthma exacerbations can have a significant impact under the American Medical Association guidelines, whereas emergency department visits and/or hospitalizations for status asthmaticus are the deciding criteria for disability under Social Security guidelines (52).

Disability assessment must be based on a valid impairment assessment, which can then be translated into an appropriate workplace prescription. An objective and rational medical summary by the primary treating physician is essential, although full assessment of disability issues often requires medicolegal expertise. To assure that assessments are consistent with all relevant requirements, appropriate consultation should be obtained through specialty organizations in occupational medicine, worker's compensation programs, or the insurance industry.

Physicians and workers must understand that the determination of disability compensation depends on the specific program administering the insurance coverage. Private disability insurance policies, state worker's compensation programs, the U.S. Department of Labor (53), the Social Security Disability Program, and other state and federal programs may employ different criteria for determining eligibility. Specific questions, therefore, must be addressed in the context of the disability program in which the individual has eligibility.

To qualify for Social Security disability benefits, an individual must be unable to perform substantial gainful activity. The determination depends on the severity of the impairment, as well as the age, skills, education, and prior work experience of the worker (52). A worker can obtain Medicare benefits only if he/she is determined disabled according to Social Security guidelines (Medicare benefits begin 24 months after official determination of disability). A favorable disability decision by a private insurer would not necessarily enable similar medical coverage under Social Security regulations.

Several programs, such as Social Security and Federal Worker's Compensation (54), are federally regulated and therefore uniformly administered within the United States. Nonfederal worker's compensation, in contrast, is state regulated and subject to the unique laws of the disabled worker's jurisdiction. In some states, a medical problem that is exacerbated by work, rather than caused by work, can also lead to the award of benefits, such as medical care, salary maintenance, and occupational retraining. Some states employ impairment ratings based on American Medical Association guidelines to determine the monetary award for a work-related injury.

## REGULATORY AND POLICY CONSIDERATIONS

Clinicians should be aware of the major pertinent laws, regulations, and agencies that have relevance to patients with asthma and their families. Table 5 describes the major agencies and laws that have bearing on patients with asthma.

The primary sources of environmental evaluation criteria are as follows: (*1*) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs); (*2*) NIOSH Recommended Exposure Limits (RELs); (*3*) the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs); and (*4*) the Environmental Protection Agency National Ambient Air Quality Standards. The first three are relevant to workplace exposures, whereas the Environmental Protection Agency regulates community exposures. Most employers are legally required to meet those levels specified by an OSHA standard. The OSHA PELs reflect the feasibility of controlling exposure in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease.

A time-weighted average (TWA) exposure refers to the aver-

**TABLE 5. AGENCIES AND LAWS**

| | |
|---|---|
| Occupational Safety and Health Administration (OSHA) | |
| | In the United States, the Occupational Safety and Health Act provides that each employer has a duty to furnish all employees a workplace free from hazards that are likely to cause serious physical harm. Under this act, the Occupational Safety and Health Administration (OSHA) has primary responsibility for regulating exposures in the workplace. OSHA is an agency of the federal government, but several states have their own OSHA programs. In addition to the general duty of employers to provide a safe workplace, OSHA has a number of regulations covering specific agents |
| National Institute for Occupational Safety and Health (NIOSH) | |
| | NIOSH conducts research and makes recommendations for the prevention of work-related illnesses and injuries. Research activities can include investigating a particular workplace when requested by an employer or employees. NIOSH also is responsible for disseminating information and providing training for preventing workplace injury and illness. Unlike OSHA, which is in the Department of Labor and is predominantly a regulatory enforcement agency, NIOSH is in the Department of Health and Human Services and focuses on research and education |
| Americans with Disabilities Act (ADA) | |
| | The ADA strongly encourages employers to make accommodations to permit workers with disabilities to continue working. The physician's role is to define the person's ability rather than to assess disability. Although physicians may suggest possible accommodations, the employer is ultimately responsible for assessing whether an accommodation can be "reasonably" accomplished. Clinicians' suggestions about accommodation are particularly important for patients with asthma, for whom the employer often has less experience than for more typical physical disabilities. ADA also requires schools and other institutions to make reasonable accommodations for students |
| Family Medical Leave Act | |
| | The Family Medical Leave Act (FMLA) provides the opportunity for an employee to take leave (up to 12 weeks of unpaid, job-protected leave in a 12-month period) in order to care for a sick relative or if they are sick themselves. This can help parents care for children with asthma without major repercussions on their employability or their insurance coverage |
| State and County Regulations | |
| | County health departments and state health departments often have regulatory authority for health conditions in public facilities such as schools and public employee workplaces. Unlike OSHA, their mandate is often less restricted and therefore they can deal with a broader range of problems (e.g., most state/municipal health agencies could act in the absence of a specific regulation for the substance of concern) |
| Workers' Compensation Laws | |
| | Workers' compensation laws differ among states. Laws generally require that an illness be work related for benefits. In some jurisdictions, a problem that is exacerbated by work, rather than caused by work, also can justify benefits. These benefits include medical care and salary maintenance, and may also include occupational retraining. In some states, once causation is established, benefits are awarded on the basis of impairment. In those states that base compensation on ability to work rather than on impairment per se, consideration of accommodation is particularly relevant. If accommodation is possible, then the extent of disability is limited. Because workers' compensation benefits are typically low, physicians should be particularly cautious about overstating the extent of disability in the belief that this is helping their patients |

age airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have short-term exposure limits or ceiling values that are intended to supplement the TWA when there are recognized toxic effects from higher exposures over short-term periods. For example, short-term, higher level exposures may be more relevant than TWAs for evaluating cause and exacerbation of asthma.

Clinicians cannot rely on these regulatory standards to adequately protect all persons with asthma. OSHA regulations seek to protect most workers and are not designed to provide adequate protection for the unusually susceptible worker (such as someone with asthma or allergic sensitization). Thus, an employer's statement that they meet OSHA regulations does not guarantee adequate safety for all employees. In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce adverse health effects, even if the occupational exposures are controlled at the level set by the regulatory criterion.

## CONCLUSIONS

Management of asthma risk at work, in schools, and during recreation requires a comprehensive approach involving patients and their families, health providers, employers, and governmental agencies. There is ample evidence for the risks of asthma exacerbations in work and school environments contaminated by hazardous fumes, gases, dusts, smokes, and mists. There is little evidence to suggest higher risks for asthma exacerbations among individuals engaging in recreational activities in physically hazardous settings. Environmental controls, organizational policies, and adherence to therapeutic recommendations form the basis for preventing the initiation and exacerbation of symptoms attributable to asthma. Even with appropriate environmental controls and medication regimens, some individuals may sustain respiratory impairment causing partial or total disability.

The wage and health benefits available to the disabled individual depend on the eligibility criteria of private and state/federal governmental insurance programs. Regulatory approaches to controlling environmental exposures protect most, but not all, individuals susceptible to asthma.

This statement was developed by an ad hoc subcommittee of the Assemblies on Behavioral Science and Environmental and Occupational Health. Members of the Subcommittee are:

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